

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
IRRIGATION WATER CONVEYANCE
NONREINFORCED CONCRETE DITCH AND CANAL LINING**

(Ft)
CODE 428A

DEFINITION

A fixed lining of impervious material installed in an existing or newly constructed irrigation field ditch, irrigation canal, or lateral.

PURPOSE

To prevent waterlogging of land, to maintain water quality, to prevent erosion, and to reduce water loss.

CONDITIONS WHERE PRACTICE APPLIES

Ditches and canals to be lined shall serve as integral parts of an irrigation water distribution or conveyance system that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Lined ditches and canals shall be located where they are not susceptible to damage from side drainage flooding, or they shall be protected from such damage.

Non-reinforced concrete linings shall be installed only in well-drained soils or on sites where sub-grade drainage facilities are installed with or before the lining.

Non-reinforced concrete linings shall not be installed on sites susceptible to severe frost heave or on sites where experience has indicated that the sulfate salt concentration in the soil causes rapid concrete deterioration.

On sites where sulfate concentrations exist, concrete linings may be used only if they are made using special sulfate-resistant cement as shown in **Table 1**.

Table 1

**Types of Cement Required for Concrete
Exposed to Sulfate Attack**

Percentage water-soluble Sulfate (as SO ₄) in soil samples	Sulfate (as SO ₄) in water samples, ppm	Cement type
0.00 to 0.10	0 to 150	I or IP
0.10 to 0.20	150 to 1,500	II, II w/Class F pozzolan ¹ or IP (MS) ¹
0.20 to 2.0	1,500 to 10,000	V, V w/Class F pozzolan ² , II w/Class F pozzolan ² , or IP (MS) ²
2.0 or more	10,000 or more	V plus Class F pozzolan ²

¹R factor less than 1.5 for substituted or blended cement.

²R factor less than 0.75 for substituted or blended cement, where $R = (\text{CaO}-5) / \text{Fe}_2\text{O}_3$

CRITERIA

Capacity. A lined ditch or canal shall have enough capacity to meet its requirement as part of the planned irrigation water distribution or conveyance system without damage of overtopping.

Design capacity shall be enough to provide an adequate irrigation system for all methods of irrigation planned for use in the area served.

For design purposes, the capacity shall be considered to be equal to the capacity as computed with the Manning Formula by using a

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coefficient of roughness "N" of not less than **0.015**.

Velocity. To avoid unstable surge flows, restrict a design velocity in excess of **1.7** times the critical velocity to straight reaches that discharge into a section or structure designed to reduce the velocity to less than critical velocity. The maximum velocity in these straight reaches shall be 15 feet per second. In ditch reaches from which water is to be delivered onto the field through turnouts, siphon tubes, or to similar means, the velocity shall be less than super-critical and sufficiently low to permit operation of the planned takeout structure or device.

Freeboard. The required freeboard varies according to several factors:

- The size of the ditch or canal,
- The velocity of the water,
- The horizontal and vertical alignment,
- The amount of the storm or waste water that may be intercepted, and
- The change in the water surface elevation that may occur when any control structure is operating.

The minimum freeboard for any lined ditch or canal shall be 0.25 feet of lining above the designed water surface.

This minimum freeboard requirement is based on the assumption that the finished channel bottom elevation will vary no more than 0.1 ft from the design elevation. If a construction deviation greater than 0.1 ft is permitted, the minimum freeboard shall be increased.

Additional freeboard shall be provided if required by velocity, depth of flow, alignment, obstruction, curves, and other site conditions.

Water surface elevations. All lined ditches and canals shall be designed so that the water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to be used to provide the necessary head, the backwater effect must be considered in computing freeboard requirements. The required elevation of the water surface varies with the type of takeout structure or device used and the amount of

water to be delivered through each structure. A minimum head of 0.5 feet shall be provided.

Ditch or canal sideslopes. Non-reinforced concrete linings generally are used in ditches and canals that have either trapezoidal or parabolic cross section.

They may be used in rectangular sections if the sidewall height is not greater than 1.5 feet. Side slopes for usual construction methods shall not be steeper than shown below:

Hand-placed, formed concrete -

Height of lining less than 1.5 feet - Vertical

Hand-placed, screeded concrete -

Height of lining less than 2 ½ feet - 3/4 to 1

Height of lining between 2.5 & 3 feet - 1 to 1

Height of lining more than 3 feet - 1 ¼ to 1

Slip form concrete -

Height of lining less than 3 feet - 1 to 1

Height of lining more than 3 feet - 1 ¼ to 1

Ditch or canal banks. Ditch and canal banks shall be built up with earth to at least the top edge of the lining. In cut sections, other than in rock, a berm shall be constructed not less than 0.2 feet above the top of the lining. Banks and berms shall be wide enough to insure stability of fills and to prevent excessive deposition in cut sections.

If the bank or berm is to be used as a roadway, the minimum top width shall be adequate for the purpose.

Outside bank slopes and slopes above the berm elevation in cut sections must be flat enough to insure stability.

The minimum top width of the earth embankment supporting the ditch lining shall be 2 feet as measured from the inside face of the top edge of the lining. The side slope of the embankment shall be no steeper than 2 horizontal to 1 vertical.

Side drainage. Control measures to prevent side drainage from entering behind the ditch lining shall be accomplished by one of the following means:

- Inlet structure to the ditch.
- Structure to carry the water over or under the ditch.

- Earth dike constructed next to the ditch to act as a diversion with properly controlled outlets.
- Other effective cutoff devices between the lining and earth bank.

Lining thickness. The thickness of canal linings must be established on the basis of engineering consideration on each job. Location, canal size, velocity, sub-grade conditions, method of construction, operation, and climate shall be evaluated in establishing the thickness to be used. The minimum thickness for non-reinforced concrete linings in rectangular sections shall be 3 ½ in. For trapezoidal or parabolic sections, the minimum thickness shall be as shown in **Table 2**.

Table 2

Minimum required thickness for non-reinforced concrete ditch and canal linings

Design velocity ¹	Minimum thickness by climatic area ^{2,3,4}	
	Warm	Cold
ft/s	in	in
Less than 9.0	1.5	2.0
9.0 - 12.0	2.0	2.5
12.0-15.0	2.5	3.0

¹Velocities in short chute sections shall not be considered design velocity.

²Climatic area

Warm - Average January temperature is 40 °F and above;

Cold - Average January temperature is less than 40 °F.

³Up to an additional ½ inch of thickness may be allowed for quantity computations.

⁴Consider soil types when planning thickness of linings.

Lea, Eddy, Chavez, DeBaca, Otero, Sierra, Dona Ana, Luna and Hidalgo Counties, and that portion of Grant County that is south of the White Signal community, are in the warm climate area.

The remainder of the state is in the cold climate area.

Related structures. Plans for installing ditch or canal linings shall provide for adequate

inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation. These structures can be installed before, during, or after placement of the lining. They must be constructed or installed in such a way as not to damage the lining or to impair its effectiveness.

All structures shall meet applicable NRCS Practice Standard requirements.

Concrete mixture. Fly ash may be used to replace up to 15% of the cement, by weight when other pozzolans are not used.

Air-entrainment admixture is recommended to improve workability and reduce damage due to freeze/thaw cycles. In-place air content shall not exceed 7 percent of the volume of concrete.

Materials. All materials shall meet or exceed the minimum requirements indicated under specifications for "Materials."

CONSIDERATIONS

Capacity should be enough to deliver the water needed for irrigation to meet the design peak consumptive use of the crops in the area served.

Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation and ground water recharge.

Effects on downstream flows or aquifers that would affect other water uses or users.

Potential use for irrigation water management.

Potential changes in growth and transpiration of vegetation located next to the conveyance because of the elimination of leakage from the system.

Effects of installing the lining on the erosion of the earth conveyance and the movement of sediment and soluble and sediment-attached substances carried by water.

Effects on the movement of dissolved substances to ground water.

Effects on wetlands or water-related wildlife habitats.

Effects on the visual quality of water resources.

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Consider using fiber reinforced concrete to increase durability and reduce minor cracking.

Consider energy dissipation devices for siphon tubes and turnouts to reduce erosion.

PLANS AND SPECIFICATIONS

Plans and specifications for installing non-reinforced concrete irrigation ditch and canal linings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

This standard applies to concrete linings made of non-reinforced Portland cement concrete that is cast in place in a preformed ditch or canal section but does not include linings of pneumatically applied mortar.

This standard is restricted to installations in ditches or canals that have a bottom width not greater than 6 ft, a design capacity not greater than 100 ft³/s, and a maximum velocity of 15 ft/s.

This standard includes design and construction criteria for shaping or reshaping the ditch section as well as for the lining.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for non-reinforced concrete irrigation ditch and canal linings. The plan should document the actions needed to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be included as an identifiable part of the design. Brief statements can be used to accomplish this in the drawings and specifications, the conservation plan, job sheet, or as a separate O&M plan.

The O&M plan shall address, as a minimum, sediment/debris removal and repair or replacement of cracked or broken canal sections.